Transformational Communications

By the DON CIO Spectrum/Telecommunications Team

It is unlikely that more than a few *CHIPS* readers who use the Internet at home would tolerate yesteryear's slow speed modems if faster alternatives existed. For many businesses, using the Internet to research information, exchange technical details, transmit e-mail, and even chat globally with colleagues using Voice over Internet Protocol (VoIP) are both routine tasks and competitive necessities. Consequently, the growth of digital subscriber lines (DSL), cable loops, wireless fidelity (WiFi) hot spots and satellite Internet service to provide expanded, faster information exchange to businesses, schools and homes is explosive.

Likewise, the warfighters' demand for robust communication and near-real time transfer of data and video between battlefields creates a need for unencumbered and expanded tactical bandwidth. Laboratories, industry and academia are responding with capable solutions that will enable net-centric warfare and the Global Information Grid (GIG).

Emerging electromagnetic spectrum technology will employ greater efficiencies, thereby reducing the bandwidth required for advanced communications. Figure 1 shows a summary of bandwidth used in major military operations since 1991.

The dilemma of bandwidth availability was posed to the Defense Science Board, Department of Defense (DoD) agencies, and after Sept. 11, 2001, to non-DoD federal agencies for resolution. One interoperable solution termed "Transformational Communications" was proposed. Simply stated, it is a concept aimed to create a communications network for the intelligence agencies, space agencies and military services based on a single architecture.

A Transformational Communications Office (TCO) was established in 2002 to "coordinate, synchronize and direct implementation of a Transformational Communications Architecture." A study by the TCO led to development of the Transformational Communications Architecture (TCA), version 1.0, in October 2003. The TCA defines a long-term view for transition, emphasizing Internet Protocol (IP) driven interoperability as the enabler for new communication solutions. TCA seeks to assure information dominance through improved, shared battlefield awareness; robustly networked GIG elements; time-critical targeting; and enhanced regulatory and spectrum coordination.

The TCA documents the next generation communications capability for a global end-to-end, seamless system as a part of the GIG. This communication concept aims to leverage a combination of optical and radio frequency (RF) technologies. Based on various open standards, it will connect people and systems with high reliability, redundancy and responsiveness.

The foundations of the architecture are the Joint Tactical Radio System (JTRS) and the Transformational Communications System Military Satellite Communications (MILSATCOM). This Internet-like transport architecture between space, air, ground and sea nodes will culminate in a flexible enterprise warfighting environment.

The TCA is comprised of four segments of merged DoD, Intelligence Community (IC) and NASA infrastructure. The terrestrial infrastructure segment, network and management segment and terminal segment are composed mainly of earth-bound assets. The fourth is the space segment where assets of NASA, DoD and the IC will interoperate.

The terrestrial infrastructure segment plans interfaces to NASA and national special purpose networks, other DoD networks and teleports, and even commercial systems. It will utilize RF communication ground stations for satellite uplink and downlink. Gateway terminals will receive high capacity downlinks from relay and DoD-protected satellites. Within the United States, these gateways connect via standard optical interface and fiber to the GIG, NASA's Information Systems Network and other associated terrestrial high-speed networks. Teleports will connect MILSATCOM satellites not otherwise connected by cross-links. These teleports will also be connected via a standard optical interface and fiber to the GIG-Bandwidth Expansion (BE).

The network operations and management segment is the portion of the TCA that connects some of the ground networks of DoD, IC and NASA. It supports peering across these separately procured enclave systems so that resource sharing and fault tolerance can be supported. Network operations and management will provide the monitoring and control of gateway terminals, teleports and communications payloads that are working as network resources.

The terminal segment is composed of end users, ground stations, and space and airborne intelligence, surveillance and reconnaissance (ISR) terminals. It will perform the RF handling, waveform communications processing, and network and security protocols associated with MILSATCOM services. Standardized interfaces will become the entry point for applications and equipment to attach to the TCA. This segment will consist of a combination of legacy, programmed and proposed replacement terminals.

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The space segment will be the subject of a future article. However, for quick reference this area integrates assets of TCA SATCOM for mobile/tactical users and global intelligence via optical cross links and extremely high-frequency RF links. The space segment will extend the GIG to users without fiber connection providing improved connectivity and data transfer capability resulting in a revolutionary change in satellite communications for the warfighter.

Military services are moving toward multi-band and smaller aperture terminals to help integrate satellite communication into weapons platforms with little impact on the overall structure. The space segment will extend the GIG to users without fiber connections, providing improved connectivity and data transfer capability, resulting in a revolutionary change in satellite communications for the warfighter.

In order to ensure TCA component interoperability with the GIG Integrated Architecture, this effort and its sub-elements will participate in GIG end-to-end test bed and systems engineering activities. Elements of the net-centric GIG with which TCA will be interoperable include, but are not limited to, Information Assurance, Network Operations and Information Dissemination Management.

The insatiable demand for battlefield bandwidth has no apparent cessation. In its current configuration, a single Global Hawk UAV requires 500Mbps bandwidth — which equates to 500 percent of the total bandwidth of the entire U.S. military used during the 1991 Gulf War. In summary, the advantages presented by the Transformational Communications Architecture include:

Improved Interoperability – TCA allows a much greater number of users to freely and quickly interact with the full implementation of IP on DoD platforms. TCA transport interoperability features can enable future IC, NASA and DoD information sharing and collaboration, within the information architecture level.

High Protected Data Rates – In the pre-TCA environment, many users with requirements for protected services received service that did not offer protection. TCA provides levels of anti-jamming protection to more and smaller units at higher data rates. New nulling multibeam antennas will allow users to operate geographically closer to sources of jamming. A one-foot antenna is projected with the capability to transmit at least 12 Mbps and receive at least 1 Mbps of protected data. This reduction in user terminal antenna size provides a new "communications on the move" capability for more agile and lethal forces.

Quicker Data Access – Under TCA, the space and terrestrial network for DoD users will employ common IP network protocols. Data access, applications, and development tools will enhance the information architecture, which rides on the TCA transport architecture.

Larger Numbers of User Terminals – A single architecture deploying fully software programmable terminals will reduce costs for DoD users. It is expected that terminals will be more cost effective, enabling communications with lower echelons of warfighters.

Persistent ISR – Both space-borne and airborne ISR for the DoD and IC can be operated in a continuous mode because TCA resources will have more capacity and access to transfer data from these platforms to analysis centers.

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Figure 1.